# Narrow Band
# NB868-500mW RF Module

**User guide version V2.2.7**
**Software version V2.3.0**

ADEUNIS RF
283 rue Louis Néel - Parc Technologique Pré Roux
38920 CROLLES - France
Tel. : +33 (0)4 76 92 07 77 - Fax : +33 (0)4 76 04 80 87
www.adeunis-rf.com arf@adeunis-rf.com

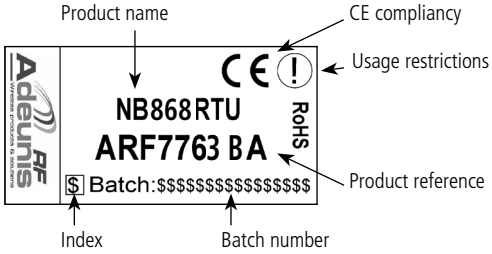
## Information

| Document information | |
|---|---|
| **Title** | NB868 Narrow Band module User guide |
| **Subtitle** | User guide version V2.2.7 |
| **Document type** | Hardware integration and software management manual |
| **Document status** | Release for NARROW BAND software version V2.3.0 |

This document applies to the following products

| Name | Reference | Firmware version |
|---|---|---|
| **NB868-RTU** | ARF7763BAB | V2.3.0 |

## Labelling




## Disclaimer

This document and the use of any information contained therein, is subject to the acceptance of the Adeunis RF terms and conditions. They can be downloaded from www.adeunis-rf.com.

Adeunis RF makes no warranties based on the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice.

Adeunis RF reserves all rights to this document and the information contained herein. Reproduction, use or disclosure to third parties without express permission is strictly prohibited. Copyright © 2012, Adeunis RF.
Adeunis RF is a registered trademark in the EU and other countries.

## Technical Support

### Website

Our website contains many useful information : modules and stand alone products information, user guides, configuration software and technical documents which can be accessed 24 hours a day.

### Email

If you have technical problems or cannot find the required information in the provided documents, contact our Technical Support by email. Use our dedicated email address (arf@adeunis-rf.com) rather than any personal email address of our staff. This makes sure that your request is processed as soon as possible.

### Helpful Information when Contacting Technical Support

When contacting Technical Support please have the following information ready:

- Complete product type & reference (e.g. Narrow Band NB868 - ARF7763BA),
- Firmware version (e.g. V2.0.4)
- Clear description of your question or the problem
- A short description of the application
- Your complete contact details

## Narrow Band Modules REGULATORY CONSIDERATIONS

### DECLARATION OF CONFORMITY

### •NB868 MHz module

We ADEUNIS RF
283 rue LOUIS NEEL
38920 CROLLES FRANCE

declare under our own responsibility that the products

Name Narrow Band NB868
Reference ARF7763BA

to which this declaration refers conforms with the relevant standards or other standardising documents:

- EN 300 220-2 (V2.3.1) (2010-02)
- EN 60950-1 (2001) + A11 (2004)
- EN62311 (2008)
- EN301 489-1 (v1.8.1) (2008-04)
- EN 301 489-3 (v1.4.1) (2002-08)

According to the RTTE Directive 99/5/EC

Notes:

- According to the 1999/519/EC «RF signal» recommendations, a minimum distance of 10cm between the product and the body is required.
- Receiver class (if applicable): 2
- Demonstration of conformity has been realized with ARF7763AA mounted on NB868 Extension pack ARF7891A

- Usage restrictions : It is the user responsibility to be sure that the configuration and use of the NB868 module fulfill all the requirements of Rec 70-03 (describing in annex 1, frequency bands, g, g1, g2, g3 or g4) . In certain cases, you may need to notify the final equipment to European administrations. Adeunis RF can assist you on regulatory aspects

Crolles, January 6th, 2012 VINCENT Hervé - CEO

## Table of contents


Information 2
Labelling 2
Disclaimer 2
Technical Support 2
Narrow Band Modules REGULATORY CONSIDERATIONS 3
NB868 MHz module 3

INTRODUCTION 6
Environmental recommendations 6
Warnings 6
Disposal of waste by users in private households within the European Union 7
EINLEITUNG 7
Hinweise zum Umweltschutz 7
Warnhinweise 8
Entsorgung der Abfälle von Betreibern in Privathaushalten innerhalb der Europäischen Union 8

**1. Modules overview 9**
1.1. Adeunis RF concept 9
1.2. Module functionality 9
1.3. Module range 9
1.4. NB868-500mW Technical specifications 9

**2. Main characterictics 10**
2.1. Form factor and footprint 10
2.2. Pins description 10
2.2.1 Pinout of the module 10
2.2.2 Pin configuration 11
2.3. Electrical & Radio characteristics 12
2.3.1 Absolute maximum ratings 12
2.3.2 General specifications 12
2.3.3 Digital specifications 12
2.3.4 Radio characteristics 13
2.3.4.1 Use at 500mW: maximum range 13
2.3.4.2 Usage up to 25mW: maximum number of channels 14
2.4. Power supply 15
2.5. Antenna 15

**3. Communication mode 16**
3.1. UART interface 16
3.1.1 UART settings 16
3.1.2 UART protocol 16
3.2. Radio interface 16
3.2.1 Packet protocol 16
3.2.1.1 Protocol description 16
3.2.1.2 Non-secured Packet Protocol 16
3.2.1.3 Secured Packet protocol 16
3.2.1.4 Transmission integrity control 17
3.2.1.5 Implementation 17
3.2.1.6 Transmission data path 17
3.2.2 Continuous asynchronous protocol 17
3.2.2.1 Description of the protocol 17
3.2.2.2 Transmission integrity control 17
3.2.2.3 Implementation 17
3.2.2.4 Transmission data path and latency 17
3.3. Addressing 18

3.4. RSSI 18
3.4.1 RSSI continuous 19
3.4.2 Frame RSSI 19
3.5. Scan Free function 19

**4. Product Configuration - Command Mode 20**
4.1. Command mode input/output 20
4.2. AT Commandes 20
4.3. Description of registers 21
4.4. Configuration coherency 23

**5. Firmware upgrade 24**

**6. Process 24**
6.1. Description of module 7763xxx 24
6.2. BOM analysis 24
6.3. Risk linked to number of reflows 24
6.4. Soldering curve 25

**7. Version history 25**

# INTRODUCTION

All rights to this manual are the exclusive property of ADEUNIS RF. All rights reserved. Copying this manual (without written permission from the owner) via printing, copying, recording or by any other means, translating this manual (in full or partially) into any other language, including all programming languages, using any electrical, mechanical, magnetic or optical devices, manually or any by other methods, is prohibited.

ADEUNIS RF reserves the right to change the technical specifications or functions of its products, or to cease manufacturing any of its products, or to cease technical support for one of its products without notice in writing and urges its customers to make sure that the information they have is valid.

ADEUNIS RF configuration software and programs are available free of charge in a non-modifiable version. ADEUNIS RF can make no guarantees, including guarantees concerning suitability and applicability for a certain type of application. Under no circumstances can the manufacturer, or the distributor of an ADEUNIS RF program, be held liable for any damage caused by the use of the aforesaid program. Program names, as well as all copyright relating to programs, are the exclusive property of ADEUNIS RF. Any transfer, granting of licences to a third party, leasing, hire, transport, copying, editing, translation, modification into another programming language or reverse engineering are prohibited without ADEUNIS RF's prior written authorisation and consent.

**ADEUNIS RF**
283, rue Louis Néel
38920 Crolles
France

Telephone +33 (0)4 76 92 07 77
Fax +33 (0)4 76 08 97 46

## Environmental recommendations

All superfluous packaging materials have been eliminated. We have done everything possible to make it easy to separate the packaging into three types of materials: cardboard (box), expanded polystyrene (filler material) and polyethylene (packets, foam protective sheets). Your device is composed of materials that can be recycled and reused if it is dismantled by a specialist company. Please observe local regulations concerning the manner in which waste packaging material, used batteries and your obsolete equipment are disposed of.

## Warnings

Valid for Narrow Band modules with the following references: ARF7763BA

Read the instructions in the manual.

The safety of this product is only guaranteed when it is used in accordance with its purpose.
Maintenance should only be carried out by qualified persons.

Please note, do not install the equipment close to a heat source or in damp conditions.

**IMPORTANT** : a minimum distance of 5cm is mandatory between two products functioning at 27dBm/500mW

Please note: for your own safety, you must ensure that the equipment is switched off before carrying out any work on it.

Please note: For your safety, the power supply circuit must be SELV (Safety Extra Low Voltage) and must be a limited power sources.

Recommendations regarding use

- Before using the system, check that the power supply voltage shown in the user manual corresponds to your supply. If it doesn't, please consult your supplier.
- Place the device against a flat, firm and stable surface.
- The device must be installed in a location that is sufficiently ventilated so that there is no risk of internal heating and it must not be covered with objects such as newspapers, cloths, curtains, etc.
- The device's aerial must be free and at least 10 cm away from any conducting material.

- The device must never be exposed to heat sources such as heating equipment.
- Do not place the device close to objects with naked flames such as lit candles, blowtorches, etc.
- The device must not be exposed to aggressive chemical agents or solvents likely to damage the plastic or corrode the metal parts.
- Install your device close to its DC power supply.

## Disposal of waste by users in private households within the European Union

This symbol on the product or on its packaging indicates that this product must not be disposed off with your other household waste. Instead, it is your responsibility to dispose of your waste by taking it to a collection point designated for the recycling of electrical and electronic appliances. Separate collection and recycling of your waste at the time of disposal will contribute to conserving natural resources and guarantee recycling that respects the environment and human health. For further information concerning your nearest recycling centre, please contact your nearest local authority/town hall offices, your household waste collection company or the shop where you bought the product.

## EINLEITUNG

Alle Rechte an diesem Handbuch sind das alleinige Eigentum der ADEUNIS RF. Alle Rechte sind vorbehalten. Jede (ohne die schriftliche Genehmigung des Eigentümers erfolgende) Wiedergabe dieses Handbuches  durch Druck, Kopie, Aufzeichnung oder jedwedes andere Mittel sowie die (vollständige oder teilweise) Übersetzung in jede andere Sprache einschließlich aller Programmiersprachen durch Verwendung welcher elektrischer, mechanischer, magnetischer, optischer, manueller Vorrichtungen oder anderen Methoden auch immer, sind verboten.

Die ADEUNIS RF behält sich das Recht vor, ohne irgendeine schriftliche Mitteilung die technischen Spezifikationen oder die Funktionen ihrer Produkte zu verändern, bzw. die Herstellung eines ihrer Produkte einzustellen oder den technischen Support für eines ihrer Produkte auszusetzen und bittet ihre Kunden inständig sich zu vergewissern, dass die ihnen zur Verfügung stehenden Informationen zutreffend sind.

Die Konfigurations- und Programmsoftware der ADEUNIS RF steht kostenlos in einer Version zur Verfügung, die nicht verändert werden kann. Die ADEUNIS RF kann keinerlei Garantie und auch keine Garantie zur Eignung und Anwendbarkeit für eine Applikation bestimmten Typs gewähren. Der Hersteller oder der Verkäufer eines Programms der ADEUNIS RF kann in keinem Fall für irgendwelche Schäden haftbar gemacht werden, die durch die Anwendung des besagten Programms gegebenenfalls verursacht werden könnten. Die Bezeichnungen der Programme sowie alle Urheberrechte zu den Programmen sind das alleinige Eigentum der ADEUNIS RF. Jede Übertragung, Gewährung von Lizenzen an einen Dritten, Leasingvergabe, Vermietung, Übereignung, Kopie, Übersetzung, Modifizierung in eine andere Programmiersprache oder durch ein Reverse Engineering ist ohne die schriftliche Genehmigung und ohne das Einverständnis der ADEUNIS RF verboten.

ADEUNIS RF
283, rue Louis Néel
38920 Crolles
France

Tel +33 (0)4 76 92 07 77
Fax +33 (0)4 76 08 97 46

## Hinweise zum Umweltschutz

Alle überflüssigen Verpackungsmaterialien wurden vermieden. Wir haben auch alles getan, was uns möglich ist, damit die Verpackung ohne Weiteres in drei Typen von Werkstoffen getrennt werden kann : Karton (die Schachtel), geschäumtes Polystyrol (Dämmmaterial) und Polyäthylen (Beutel, Schaumfolie zum Schutz). Ihr Gerät besteht aus Werkstoffen, die recycelt und weiterverwendet werden können, wenn es von einem darauf spezialisierten Unternehmen demontiert wird. Beachten Sie bitte die jeweils geltenden örtlichen Vorschriften zur Entsorgung der Verpackungsmaterialien, der verbrauchten Batterien und Ihres ausgemusterten Gerätes.

## Warnhinweise

Gültig für die Relaisempfänger mit den Artikelnummern : ARF7763BA

Lesen Sie die Anleitungen dieses Handbuches.

Die durch dieses Produkt gewährte Sicherheit kann nur bei einer Anwendung entsprechend dem vorgesehenen Einsatzzweck gewährleistet werden.

**WICHTIG**: ein Mindestabstand von 5 cm ist zwingend zwischen zwei Produkten funktioniert bei 27dBm/500mW

Achtung ! Zu Ihrer eigenen Sicherheit ist es unerlässlich, das Gerät vor jedem technischen Eingriff spannungsfrei zu schalten.

Achtung ! Zu Ihrer eigenen Sicherheit die Stromversorgung Schaltung muss SELV (Safety Extra Low Voltage) sein und muss der begrenzten Stromquellen sein.

Empfehlungen für den Einsatz

- Vor dem Einsatz des Systems müssen Sie überprüfen, dass die in der Bedienungsanleitung angegebene Anschlussspannung den Werten Ihrer Stromversorgung entspricht. Anderenfalls wenden Sie sich bitte an Ihren Lieferanten.
- Stellen Sie das Gerät auf einer ebenen, festen und stabilen Fläche auf.
- Um jede Gefahr einer inneren Erwärmung des Gerätes zu vermeiden, ist dieses an einem gut belüfteten Ort aufzustellen und darauf zu achten, dass keine Gegenstände wie Zeitschriften, Matten, Vorhänge u. a. darauf abgelegt werden.
- Die Antenne des Gerätes muss frei liegen und von jeglichen leitenden Werkstoffen mindestens 10 cm entfernt sein.
- Das Gerät darf niemals der Einwirkung von Wärmequellen oder Heizgeräten ausgesetzt sein.
- Das Gerät darf sich niemals in der Nähe von Gegenständen mit offener Flamme befinden, wie brennenden Kerzen, Schweißbrennern usw.
- Das Gerät darf niemals der Einwirkung von aggressiven Chemikalien oder Lösemittel ausgesetzt werden, die geeignet sein könnten, den Kunststoff zu beschädigen oder die Metallteile zu korrodieren.
- Stellen Sie Ihr Gerät in der Nähe der Quelle seiner Spannungsversorgung DC auf.

## Entsorgung der Abfälle von Betreibern in Privathaushalten innerhalb der Europäischen Union

Dieses Symbol auf dem Produkt oder auf seiner Verpackung weist darauf hin, dass dieses Produkt nicht gemeinsam mit Ihrem anderen Haushaltsmüll entsorgt werden darf. Stattdessen haben Sie dafür Sorge zu tragen, Ihre Abfälle bei einer Erfassungsstelle zu entsorgen, die auf das Recycling elektrischer und elektronischer Geräte spezialisiert ist. Die gesonderte Erfassung und das Recycling ihrer Abfälle bei der Entsorgung tragen dazu bei, die natürlichen Ressourcen zu bewahren und ein Recycling zu gewährleisten, das dem Schutz der Umwelt und der menschlichen Gesundheit dient. Für weitere Informationen zu der Ihrer Wohnung am nächsten gelegene Recyclingstelle wenden Sie sich bitte an die örtliche Gemeindeverwaltung, an die zuständige Dienststelle für die Müllabfuhr oder an das Geschäft, in dem sie das Gerät gekauft haben

# 1. Modules overview

## 1.1. Adeunis RF concept

The idea is to provide the user with a module which is ready for sending and receiving data over a radio link thus enabling the user to focus on the development of its application. The aim is to relieve the user of having to deal with the complex radio management.

This specific range of Narrow Band modules has been created to provide extra longe range «point-to-point» transmissions on unlicensed frequency bands and the use of multiple modules in the same environment at maximum power.

## 1.2. Module functionality

The module consists in a bidirectional RF transceiver implementing an RF-UART gateway. Basically, data sent to the module on its UART interface are transmitted on the air and vis versa.
The module is build around two main components:

- The "Digital" block based on a STM32F101x microcontroller belonging to the ARM Cortex-M3 family.
- The "Radio" block based on the TI CC1120 radio chip combined to an optimized RF front-end.

The radio block handle RF modulation and demodulation while the digital block drives the radio engine and offers a simplified end user interface with a large panel of functionalities.

The following embedded features are available:

- Programmable RF data rate and modulation
- Programmable UART data rate with optional Flow control
- Programmable RF output power
- Large set of Narrow Band RF channels allowing multiple different system to communicate in the same environment
- Embedded protocol for point to point and point to multi-point communication with "Transparent" and "addressing" mode
- Optional control of RF data integrity by CRC and RF Scrambling mode
- "Standby mode" for saving energy when radio transmission is not required

## 1.3. Module range

The Narrow Bands range is made up of 4 modules.

- NB868 - allows data transmission up to 20km (line of sight). Up to 19 radio links (channels) can be used in the same environment.
- NB868-25mW - allows data transmission up to 4km (line of sight). Up to 506 radio links (channels) can be used in the same environment.
- NB169 - allows data transmission up to 30km (line of sight). Up to 6 radio links (channels) can be used in the same environment.
- NB458 - allows data transmission up to 15km (line of sight). Up to 80 radio links (channels) can be used in the same environment.

The modules are pin-to-pin compatible.

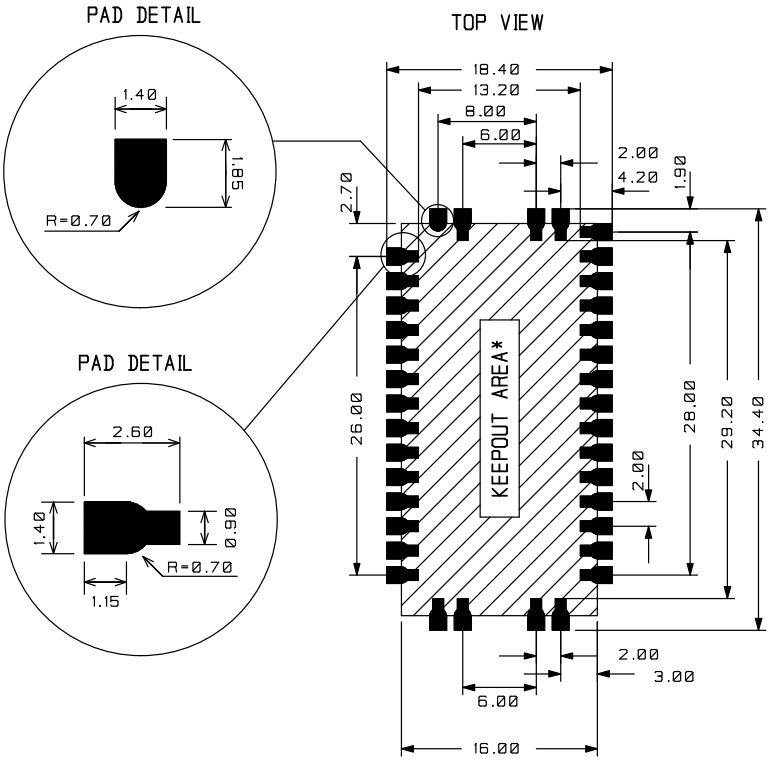
## 1.4. NB868-500mW Technical specifications

| **Technical specifications** | |
|---|---|
| Communication | Point-to-point / Point-to-multipoint |
| Module configuration | Through AT commands |
| Radio data rate | 2.4, 9.6, 38.4 and 57.6 kbps |
| UART data rate | 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6 and 115.2 kbauds |
| UART TTL port | TxD - RxD - RTS - CTS |
| Adressing mode | Transparent or Addressed |
| Frequencies | 868 MHz |
| Programmable RF output power | Up to 500 mW (27 dBm) |
| Sensitivity | Down to -120 dBm @ $BER10^{-3}$ (data rate 2.4kbps) |
| Operating range (open space) | External antenna: up to 20 km |
| Operating voltage | 3v to 3,6v (3,3v nominal) |
| Tx/Rx consumption (maxi)/Sleep | 700mA / 40mA / 8µA |
| Operating temperature | -40°C / +85°C |
| Dimensions | 32x 16 x 2.8mm (4mm with shield) |

# 2. Main characterictics

## 2.1. Form factor and footprint

### Footprint of the module

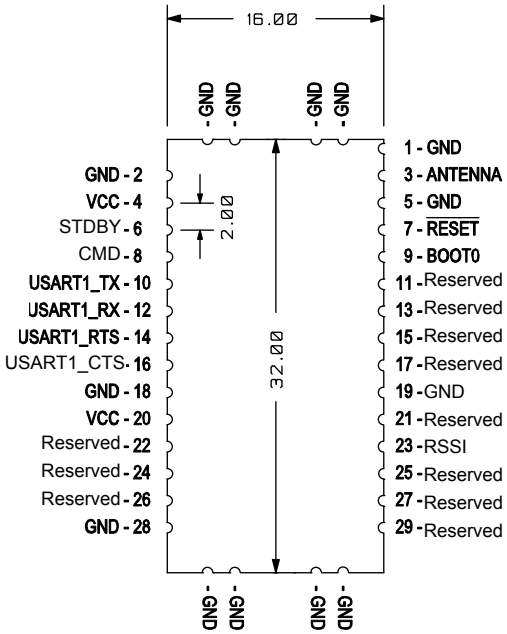



* NO COPPER AND TRACKS UNDER THE MODULE

Note : dxf and gerber files are available on request

## 2.2. Pins description

### 2.2.1 Pinout of the module



### 2.2.2 Pin configuration

| Pin module | Pin name | I/O (1) | Description |
|---|---|---|---|
| 1 | GND | | **Ground** (2) |
| 2 | GND | | **Ground** (2) |
| 3 | ANTENNA | | **RF output**<br>Must be adapted with 50 ohms matching |
| 4 | VCC | | **Supply voltage** (2) |
| 5 | GND | | Ground (2) |
| 6 | /STANDBY | I<br>Internal pull-down | **Standby mode** activation/deactivation<br>May be left unconnected if standby mode is not used |
| 7 | /RESET | I | **Reset**<br>Should be connected to the host controller, may be left unconnected if reset not used |
| 8 | CMD_MODE | I<br>Internal pull-down | **Command mode**<br>Should be connected to the host controller, may be left unconnected if command mode not used |
| 9 | BOOT_MODE | I | **Boot loader activation** (note : this pin must not be left unconnected<br>Must be set to GND for normal operation (pull-down 47k Ohms advised)<br>Must be set to VCC for firmware upgrade |
| 10 | UART_TX | O | **Data output**<br>Must be connected to the host controller |
| 11 | Reserved | | (3) |
| 12 | UART_RX | I<br>Internal pull-up | **Data input**<br>Must be connected to the host controller, must be left unconnected if not used |
| 13 | Reserved | | (3) |
| 14 | UART_RTS | O | **UART flow control**<br>Must be connected to the host controller if hardware flow control is used, must be left unconnected if not used |
| 15 | Reserved | | (3) |
| 16 | UART-CTS | I<br>Internal pull-down | **UART flow control**<br>Must be connected to the host controller if hardware flow control is used, must be left unconnected if not used |
| 17 | Reserved | | (3) |
| 18 | GND | | **Ground** (2) |
| 19 | GND | | **Ground** (2) |
| 20 | VCC | | **Supply voltage** (2) |
| 21 | Reserved | | (3) |
| 22 | Reserved | | (3) |
| 23 | RSSI_PWM | O | **RSSI level** of radio channel<br>Must be connected to the host controller if RSSI has to be used |
| 24 | Reserved | | (3) |
| 25 | Reserved | | (3) |
| 26 | Reserved | | (3) |
| 27 | Reserved | | (3) |
| 28 | GND | | **Ground** (2) |
| 29 | Reserved | | (3) |
| | | | |
| 8 pins on both little side of the module | GND | | Ground (4) |

(1) Described from the module point of vue (I : Is an input of the module, O is an output of the module) - The internal pull-up/pull-down is between 30KΩ and 60KΩ, typical 45KΩ.
(2) All GND and VCC pins must be connected
(3) Must be left unconnected or connect to an input of the host controller
(4) Should be connect to GND to get best RF sensitivity

## 2.3. Electrical & Radio characteristics

### 2.3.1 Absolute maximum ratings

| Parameter | Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|
| Supply voltage | -0.3 | | 3.9 | V | |
| Storage Temperature range | -40 | | -125 | °C | |
| Input RF level | | | +10 | dBm | |
| Voltage on any pin | -0.3 | | 3.9 | V | |

### 2.3.2 General specifications

| Parameter | Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|
| Supply Voltage Range | 3 | 3.3 | 3.6 | V | |
| Temperature Range | -40 | | +85 | °C | |
| Transmitter consumption | | 560<br>300 | 700 | mA (*) | @27dBm<br>@20dBm |
| Receiver consumption | | 35 | 40 | mA | |
| Stand by consumption | | 8 | | µA | |

(*) Consumption measured in conducted mode.

### 2.3.3 Digital specifications

The table below summarizes all the different electrical input/output generic characteristics of the modules :

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input low level voltage | TTL ports | -0.5 | | 0.8 | V |
| $V_{IH}$ | Std I/O input level voltage | | 2 | | $V_{DD}$+0.5 | |
| | I/O FT input high level voltage | | 2 | | 5.5 | |
| $V_{IL}$ | Input low level voltage | CMOS ports | -0.5 | | $0.35V_{DD}$ | V |
| $V_{IH}$ | Input high level voltage | | $0.65V_{DD}$ | | $V_{DD}$+0.5 | |
| **Symbol** | **Parameter** | **Conditions** | **Min** | | **Max** | **Unit** |
| $V_{OL}$ | Output Low level voltage for an I/O pin when 8 pins are sunk at the same time | TTL port<br>$I_{IO}$=+8mA<br>2.7 V <VDD<3.6V | | | 0.4 | V |
| $V_{OH}$ | Output High level voltage for an I/O pin when 8 pins are sourced at the same time | | $V_{DD}$-0.4 | | | |
| $V_{OL}$ | Output Low level voltage for an I/O pin when 8 pins are sunk at the same time | CMOS port<br>$I_{IO}$=+8mA<br>2.7 V <$V_{DD}$<3.6V | | | 0.4 | V |
| $V_{OH}$ | Output High level voltage for an I/O pin when 8 pins are sourced at the same time | | 2.4 | | | |
| $V_{OL}$ | Output Low level voltage for an I/O pin when 8 pins are sunk at the same time | $I_{IO}$=+20mA<br>2.7 V <$V_{DD}$<3.6V | | | 1.3 | V |
| $V_{OH}$ | Output High level voltage for an I/O pin when 8 pins are sourced at the same time | | $V_{DD}$-1.3 | | | |
| $V_{OL}$ | Output High level voltage for an I/O pin when 8 pins are sourced at the same time | $I_{IO}$=+6mA<br>2 V <$V_{DD}$<2.7V | | | 0.4 | V |
| $V_{OH}$ | Output High level voltage for an I/O pin when 8 pins are sourced at the same time | | $V_{DD}$-0.4 | | | |

### 2.3.4 Radio characteristics

The table below shows the main RF characteristics of NB868 module. We can separate 2 types of use:

- High powers up to 500mW
- Powers < or equal to 25mW.

#### 2.3.4.1 Use at 500mW: maximum range

The table below enables users to configure their NB868 modules to obtain the longest possible range at 500mW in the 869.4 to 869.6MHz band.

| Parameters | | | | | Conditions |
|---|---|---|---|---|---|
| **RF data rate** | 2.4kbps | 9.6kbps | 38.4kbps | 57.6kbps | Modification through AT COMMAND ATS254 |
| **Available channels** | Up to 19 :<br>869,4125 MHz<br>869,425 MHz<br>869,4375 MHz<br>869,450 MHz<br>869,46255 MHz<br>869,475 MHz<br>869,4875 MHz<br>869,500 MHz<br>869,5125 MHz<br>869,525 MHz<br>869,5375 MHz<br>869,550 MHz<br>869,5625 MHz<br>869,575 MHz<br>869,5875 MHz<br>869,600 MHz<br>869,6125 MHz<br>869,625 MHz<br>869,6375 MHz | Up to 9 :<br>869,425 MHz<br>869,450 MHz<br>869,475 MHz<br>869,500 MHz<br>869,525 MHz<br>869,550 MHz<br>869,575 MHz<br>869,600 MHz<br>869,625 MHz | Up to 7 :<br>869,450 MHz<br>869,475 MHz<br>869,500 MHz<br>869,525 MHz<br>869,550 MHz<br>869,575 MHz<br>869,600 MHz | Up to 3 :<br>869,475 MHz<br>869,525 MHz<br>869,575 MHz | Modification through AT COMMAND ATS200<br><br>RF power up to 27dBm (500mW)<br><br>other frequencies available in the sub-band 863-870MHz<br><br>Please refer to the ARF868 channel list for more information<br><br>http://www.adeunis-rf.com/media/downloads/108/trad_file/fre/arf868_radio_modems_channels_list_v1.1.pdf |
| **Available RF radiated power** | 7 levels<br>+27 dBm<br>+25 dBm<br>+23 dBm<br>+20 dBm<br>+17 dBm<br>+14 dBm<br>+10 dBm | | | | Modification through AT COMMAND ATS231 |
| **Modulation** | 2 GFSK | 4 GFSK | | | |
| **RX sensitivity** | -122dBm | -116dBm | -112dBm | -110dBm | @BER 10e-3 |
| **Range** | Up to 20km | Up to 15km | Up to 10km | Up to 10km | in open field |
| **Duty cycle** | 10% | | | | Depending on the use |
| **Spacing** | 12.5kHz* | 25kHz | 50kHz | 75kHz | * spectral occupancy 2.4kbps being slightly greater than 12.5KHz, Adeunis RF advocates use N-2/N+2 |
| **Rejection on adjacent channel (N-1/N+1)** | 46dBc | 50dBc | 39dBc | 39dBc | |
| **Alternate channel rejection (N-2/N+2)** | 46dBc | 50dBc | 39dBc | 39dBc | |
| **Blocking** | >75dB | | | | @ +/-1 MHZ, +/-2 MHz, +/- 10 MHz Conducted measurement |

#### 2.3.4.2 Usage up to 25mW: maximum number of channels

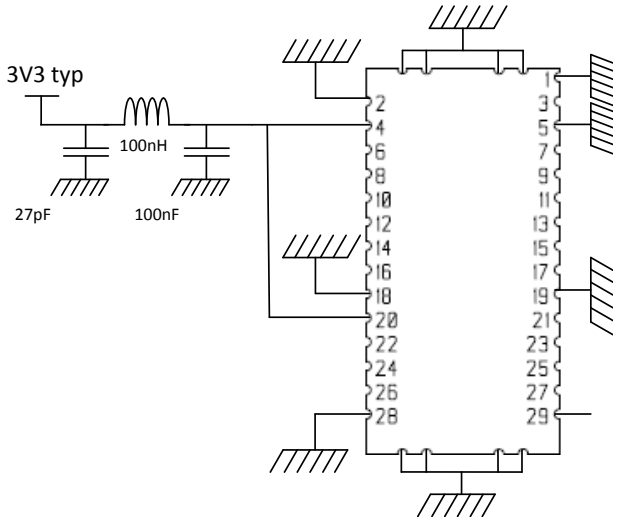
The rest of the 863-870MHz band is segmented into sub-bands of 25mW, each with their regulatory requirements. The NB868 module makes the best use of all the possibilities of this band to enable a maximum number of applications. The characteristics are given in the table below:

| Parameters | | | | | Conditions |
|---|---|---|---|---|---|
| **RF data rate** | 2.4kbps | 9.6kbps | 38.4kbps | 57.6kbps | Modification through AT COMMAND ATS254 |
| **Available channels** | Up to 506 | Up to 249 | Up to 80 | Up to 60 | Modification through COMMAND ATS200<br><br>For each frequency is assigned a channel number «C» with the formula : Frequency = 863.0125 + ((C-13)*0.0125) with C= 13 to 571.<br><br>C values available depend on the data rate.<br><br>Please refer to the ARF868 channel list for more information<br><br>http://www.adeunis-rf.com/media/downloads/108/trad_file/fre/arf868_radio_modems_channels_list_v1.1.pdf |
| **Modulation** | 2 GFSK | 4 GFSK | | | |
| **Range** | Up to 4km | Up to 2km | Up to 1km | Up to 1km | in open field |
| **Duty cycle** | Up to 1%<br>Depending on the frequency used and the channel | | | | See CEPT Recommendation 70-03 for more information |
| **Spacing** | 12.5kHz* | 25kHz | 50kHz | 75kHz | * spectral occupancy 2.4kbps being slightly greater than 12.5KHz, Adeunis RF advocates use N-2/N+2 |
| **Rejection on adjacent channel (N-1/N+1)** | 46dBc | 50dBc | 39dBc | 39dBc | |
| **Alternate channel rejection (N-2/N+2)** | 46dBc | 50dBc | 39dBc | 39dBc | |
| **Blocking** | >75dB | | | | @ +/-1 MHZ, +/-2 MHz, +/- 10 MHz<br>Conducted measurement |

## 2.4. Power supply

The module power supply is made between the VCC pin (pins 4 and 20) and GND and must be between 3V and 3.6 V, 3.3 V typical.
As described in the diagram below, we suggest adding a filter cell on the module voltage power supply pin (Vcc).
Each «GND» must be connected by vias to the ground plane of the motherboard (with the shortest distance). The unnumbered «GND» located at the ends of the module are not required but are recommended for maximum receiver sensitivity.

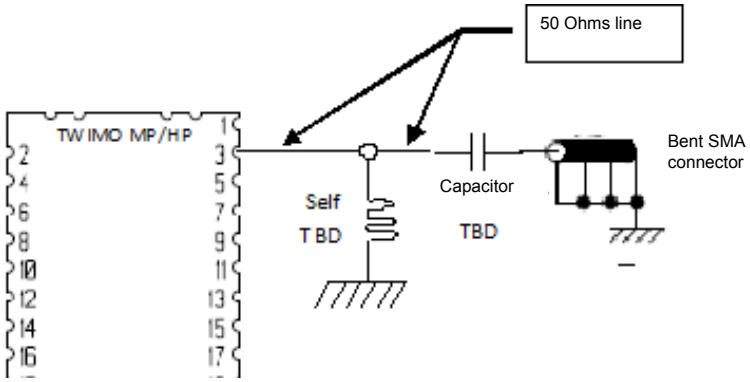
- If used, the100nH inductor will have a resonant frequency> 1GHz in order to be effective at 869MHz, frequency band of the NB868 module
- The design of the power supply must be able to provide a current up to 700mA, corresponding to the maximum consumption of the module transmitting at maximum power.




## 2.5. Antenna

ADEUNIS RF will assist you in your choice of antennas so as to optimize the performance of your products. Feel free to contact us for more information. We suggest the schematic below :

- The footprint of the inductor and capacitor are useful to ensure good impedance matching between antenna and modules. The values will depend on the working RF frequency and characteristics of the antenna.
- The SMA connector can be bent or straight depending on the selected antenna but is not essential. We could very well consider 8.6 cm welded wire antennas directly on the PCB either horizontally or vertically. However and wherever possible, it is interesting to keep the footprint of SMAs as to facilitate the development for the degrees of freedom offered an application point of view (offset antenna, etc ...). We would offer the antennas associated with these connectors.
- For a quick set-up, we recommend not to get the self, to install the capacitor to 27 pF (or replace it by a short circuit or a 0 ohm resistor) and solder a 8.6 cm length wire behind the capacitor.



# 3. Communication mode

The RTU module is ready for transmission and reception operations at first power-up without any configuration effort required. It starts in communication mode allowing to directly sends and receive data. The default UART configuration is set to 9600bps, 8 data bits, 1 stop bit and no parity.

By default, the module is permanently listening the RF interface and the UART port.
- When an incoming frame is demodulated on the RF interface, the data payload of the frame is transmitted on the UART port.
- When an incoming data is detected on the UART port, it is modulated into a frame on the RF interface.

## 3.1. UART interface

### 3.1.1 UART settings

The UART port of the module is the main interface for the host controller.

The communication requires 10 bits for each byte to transmit, including one start bit followed by 8 data bits and then one stop bit. The Start bit value is the logical "0" while the stop is the logical "1" value. There is no parity bit in the transmission.

The data rate settings can be configured with the following rate: 9.6 / 19.2 / 38.4 / 57.6 / 115.2kbps using the S210 register.

Please note that this UART port does not support electrical RS232 characteristics. An external RS232 driver has to be used if RS232 interface is required.

### 3.1.2 UART protocol

There is no specific protocol to respect for data transmission and reception. Each byte sent on the UART port is reported on the RF interface and vis versa.

## 3.2. Radio interface

### 3.2.1 Packet protocol

#### 3.2.1.1 Protocol description

NB RTU module uses a packet oriented protocol on its RF interface. The data coming from the UART interface are accumulated in an internal fifo in the module and then encapsulated in an RF frame. The maximum amount of data that can be transferred into a single radio packet can reach 1024 Bytes.

The maximum packet size can be set up in S218 register from 1 to 1024 bytes. Each new packet introduces some latency in the transmission delay caused by the RF protocol overhead. The RF protocols encapsulate the data payload with the following elements:
- A preamble pattern required for receiver startup time
- A bit synchronization pattern to synchronize the receiver on the RF frame
- Other protocol field such as source address and destination address, payload length, optional CRC and internal packet type field.

The incoming fifo may accumulate up to 1024 data byte. No more data has to be set in the fifo while a 1024 bytes block of data has not been released by the radio transmission layer. To prevent from input fifo overrun, the hardware flow control may be activated. In this case, the RTS signal (PIN 14 of the module) will be set when the incoming fifo is almost full to prevent the host controller from sending new data.

#### 3.2.1.2 Non-secured Packet Protocol

In non-secured mode, each packet is transmitted without acknowledgment; The transmitter doesn't know if packet has been received.

#### 3.2.1.3 Secured Packet protocol

In secured mode, each packet is transmitted and acknowledged by the receiver. If a packet isn't acknowledged, the module proceeds with two other attempts.
Following this sequence, the transmitter returns '>' if the packet has been received, or '#' if no acknowledgement has been received after the three attempts.
**Importante note** : the addressed mode must be activated in order to use the secured mode.

#### 3.2.1.4 Transmission integrity control

The RF protocol includes a 16 bits CRC. Each data extracted from an RF packet with an invalid CRC is silently discarded by the module state machine. The CRC ensures that all the data received are valid. It may be deactivated for user whose protocols already have an integrity control mechanism or when some error corrections are implemented by user protocols.

#### 3.2.1.5 Implementation

The Packet protocol is selected by the S222 register.
- Non-secured protocol : S222=0
- Secured protocol : S222=2

#### 3.2.1.6 Transmission data path

In packetized mode, the packet size is specified through register S218.
The module starts the transmission of a complete packet when the number of data specified in S218 has been received.
If the number of data is inferior, an incomplete packet will be constituted when time out (specified in register S217) will be reached.

### 3.2.2 Continuous asynchronous protocol

#### 3.2.2.1 Description of the protocol

The continuous asynchronous protocol enables data transfer from the UART interface to the radio link with the lowest possible latency. It is associated with radio modulations enabling a wide range of air data rate and ranges to be covered. This is the mode that will allow you to use the NB868 module to the maximum of its possibilities.

- In transmission, data entering on the UART is immediately transmitted into the "air".
- In reception, data from the RF frames is transmitted progressively to the UART interface.

There is no buffering of complete radio frames before or after transmission on the serial link.
However, the product has buffering enabling a buffer to be performed if the radio and UART data rates are different. The UART interface does not require a specific protocol. Each octet transmitted is transferred into the air and vice versa.
Thanks to its low latency and the absence of a protocol on the UART port, the NB868 module used with the continuous asynchronous protocol is completely transparent in the replacement of a wire link.

#### 3.2.2.2 Transmission integrity control

By definition, the continuous protocol can not be cut. There is therefore neither CRC calculation nor control of data integrity.

#### 3.2.2.3 Implementation

The continuous asynchronous protocol is selected by the S222 register.
It can use the following radio data rates: 2.4kbps, 9.6kbps, 38.4kbps and 57.6kbps. The adjustment of the radio data rate is done via the S254 register.

The notions of addressing (broadcast communication, group communication and addressed communication between products) are available and described below.

#### 3.2.2.4 Transmission data path and latency

Transmission delay from one equipment to another will depend on different factor:
- The UART transmission rate of the transmitter
- The UART transmission rate of the receiver
- The radio transmission rate and the radio modulation used
- The radio protocol overhead (packet split, preamble, synchronization and other protocol fields)
- The input data fifo threshold and timeout

An RF transmission can starts according following evens :
- either a timeout (S217)
- or a quantity of data in the buffer memory (S218)

The first of these two limits reached triggers transmission start.

When the number of octets in the buffer memory reaches the threshold of register S218 before the timeout of register S217, it is triggering on data.

On the other hand, when the timeout of register S217 expires before the data in the buffer memory reach the threshold of register S218, it is triggering on time.

It should be noted that programming register S217 to 0 (no timeout) means that the S218 register threshold must be reached to start transmission.

## 3.3. Addressing

The product has various addressing modes that are configurable via the product registers. The following modes are available:
- Transparent mode without sub-network
- Transparent mode with sub-network
- Addressed mode without sub-network
- Addressed mode with sub-network

The transparent modes are intended for inter-product communication: all products are recipients of the frames transmitted. The addressed modes enable communication to one or more products (creation of sub-groups).

Transparent mode without sub-network
- In the Transparent mode without sub-network all products within range receive the frames from the transmitting products. The configuration required for this mode of communication is as follows :
- S220=0 (transparent mode)
- S253=0 (no group)

Transparent mode with sub-network:
The sub-networks enable groups of products to be created that communicate with each other within the same sub-network. Products in sub-network 1 cannot see those in sub-network 2 and vice versa. On the other hand all the products are visible between themselves within the same sub-network.
- S220=0 (transparent mode)
- S253=Number of the sub-network varying from 1 to 255

when register S253 is set to 255, the frame is broadcast to the whole of the sub-network.

Addressed mode without sub-network:
In the addressed mode without sub-network a product communicates with a specified addressee. Only the addressee receives the frames from the transmitting products. The configuration required for this mode of communication is as follows:
- S220=1 (address mode)
- S253=0 (no sub-network)
- S252=local address (16 bit address)
- S256=address of the recipient (16 bit address)

When register S256 is set to 65535, the frame is broadcast and visible by all equipment within range.

Addressed mode with sub-network:
The products always communicate within the same sub network. This means that two products with identical addresses and different sub-network numbers do not communicate with each other. The only case of inter-network communication is when S256=255 and S253=255.
- S220=1 (address mode)
- S253= sub network number varying from 1 to 255 (255 is used for broadcast between the sub-network)
- S252= local address (address on 8 bits)
- S256= recipients address (address on 8 bits, 255 is the broadcast address within the sub-network)

## 3.4. RSSI

The Received Signal Strength Indication or RSSI provides an indication of the RF level in the selected channel.
Depending on the value observed, it indicates the availability of the channel and the noise level in the product's environment, or the quality of reception of the frames from a distant product. The terminals are -127dBm for the lower limit and -20dBm for the upper limit

The RSSI is deactivated (by default) by positioning register S230 at: 0

### 3.4.1 RSSI continuous

The RSSI is coded on one octet in absolute values of the channel level value in dBm and transmitted to the UART. The RSSI is refreshed continuously every 10 ms. There is no frame demodulation in this mode.

Selection of the continuous RSSI mode is done by register S230, by setting the value to: 4

### 3.4.2 Frame RSSI

The frame RSSI is the code on one octet at the beginning of each frame transmitted on the UART. The encoding is identical to the continuous RSSI.

Selection of the continuous RSSI mode is done by register S230, by setting the value to: 1

## 3.5. Scan Free function

The Scan Free is a function that is unique to NB868 modules.
This function enables sweeping of all channels available on the product in a few seconds. It is activated by the ATT02 command.

The NB868 module scans all the channels available and returns the RSSI levels on each of the channels to the UART link in the following form: :

Cxxx=-090dBm<cr><lf>  ; with xxx = channel no
Cyyy=-101dBm<cr><lf>  ; with yyy = No of the following channel
……

The polling time of a channel is defined as 25ms. The result of this polling may show that some channels are more usable than others in a given environment.

As a second stage and for a more reliable assessment, we can use the ATT03 command which enables one channel to be listened to over a longer period:
ATT03<c (channel)><t (polling time)>
With : <c> = Channel no
With: <t> = Polling time in seconds

**E.g.**: ATT03 529 60 -> Scan of channel 529 for 1 minute. The result returned has the following form:
C529=-087/-096/-101dBm<cr><lf>; i.e. in order: RSSI min. RSSI mean/RSSI max. measured over this period.

# 4. Product Configuration - Command Mode

The command mode is an embedded tool, accessible by the serial link via a terminal (*), enabling the programming of the module parameters using a set of instructions called: "AT command set". AT commands are used to read and write the module configuration registers. In the command mode, the radio is deactivated (in reception and transmission).
(*): Hercules types

## 4.1. Command mode input/output

The command mode entry is obtained by applying a rising edge on the CMDE_MODE pin. The pin is debounced for the time configured in the S240 register. The module returns the "CM" string when it has effectively entered command mode. Note that the command mode entry may be differed when an incoming RF frame is pushed on the UART interface. In any case, the "CM<cr><lf>" string is sent. The module backs to the communication mode on a falling edge on the CMDE_MODE pin with respect of the configured debounce time. The module returns the "O<cr><lf>" string when it has effectively leaved command mode.

The command mode entry may also be done with the UART interface by transmission of a sequence of 3 ASCII characters on the serial link. By default, the sequence is: "+++<cr><lf>", however the user can choose its own ASCII character by reprogramming register S214. The ATO command backs the module to the communication mode. The module returns the "O<cr><lf>" string when it has effectively leaved command mode.

It should be noted that exiting from the command mode is also possible automatically (timeout) by programming register S202

| Command | Description | Answer |
|---|---|---|
| +++ | Allows entry into command mode | « CM » to confirm entry in command mode. |
| ATO | Exit command mode | «O»<cr> if operation OK<br>«E»<cr> if error |

## 4.2. AT Commandes

A command starts with the two ASCII characters: "AT", followed by one or more characters and data (see C below for the syntax of AT commands available on the module).

Each command should end with a "CR" or "CR" "LF", the two possibilities are accepted. (CR signifies: Carriage Return, LF signifies: Line Feed)
On receipt of a command the module returns:

- "the data"<cr><lf>, for a reading command, type ATS<n> ? , AT/S or AT/V.
- "O" <cr><lf>, for all other types of commands if it is accepted.
- "E" <cr><lf>, if it refuses the command because of a syntax error, unknown command, unknown register, invalid parameter, etc.
- "W"<cr><lf>, if it refuses the command because the configuration requested is not authorised.
- "CM" <cr><lf>, if it accepts entry into the command mode

**Table of AT commands:**

| Command | Description | Reply |
|---|---|---|
| ATS<n> ? | Returns the contents of register **n** | Sn=y where **y** represents the contents of register **n** |
| ATS<n>=<m> | Transfer the value **m** to register **n** | «O»<cr> if operation OK<br>«E»<cr> if error<br>« W» if the operation has a configuration problem. |
| AT/S | Display as a list, the content of each User register | Sxxx=y<cr><lf> for each register |
| AT/V | Display the complete firmware version | Adeunis RF NB868<val> ????? |
| ATR | Restore the content of registers with default values. This command must be followed by an AT&W command and a module reset to ensure that all parameters have been applied. | «O»<cr> if operation OK<br>«E»<cr> if error |
| ATT02 | Starts the Scan Free mode | «Returns for each channel, its number and RSSI value associated :<br>***Cxxx=-090dBm***<cr><lf> |

| Command | Description | Reply |
|---|---|---|
| ATT03 <c> <t> | Scan of channel «c», during a «t» period , with :<br>- <c> value on three digits.<br>- <t> value from 1 to 999, by step of 1s | The command returns three values of RSSI: mini, medium and maximum. |
| AT&W | Save the register configuration in E2PROM. | «O»<cr> if operation OK<br>«E»<cr> if error |
| AT&RST | Restart the module | «O»<cr> if operation OK<br>«E»<cr> if error |
| ATO | Exit command mode | «O»<cr> if operation OK<br>«E»<cr> if error |

Example of a series of commands and corresponding replies as one could see them on a terminal:

| Syntax of the Command | Description | Syntax of the response to the next line |
|---|---|---|
| +++ | Request for entry into command mode | **CM** |
| ATS254=3 | Request for RF data rate at 9.6kbps | **O** |
| ATS200=9 | Request for channel selection = 9 | **E** -> invalid channel ! |
| ATS200=527 | Request for channel selection = 527 | **O** |
| ATS231=0 | Request for RF power at 27dBm | **O** |
| ATS200 ? | Returns S200 register value | **S200=527** |
| ATS231 ? | Returns S231 register value | **S231=0** |
| AT&W | Storage request of the registers status | **W** (the selected channel is not available at 9.6kbps RF data rate)<br>The value storage will not be performed. |
| ATO | Request to exit command mode | **W** (the selected channel is not available at 9.6kbps RF data rate)<br>The Exit will not be performed. |

Interpretation of the above example: the user wished to save a new radio configuration (channel 527, power 27dBm) after having made a parameter error (reply **E**) and an unauthorised configuration request (reply **W**). The module allows neither the saving of this invalid configuration nor the use of the product in the communication mode.

## 4.3. Description of registers

When switching on the NB868 module operates according to the last configuration saved (factory configuration if its the first switching on, or if this configuration has not been changed).

Modification commands, type **ATS**<**n**>=<**m**> or **ATR** allow the content of registers to be modified. The product is usable with each new configuration as long as it is not disconnected.
On the other hand the modified values will be applied next time the module is switched on only if they have been saved **AT&W** command

List of the registers accessible on the NB868 module :

| Register | Content | Default value | Comments |
|---|---|---|---|
| S200 | Channel number : 11 and from 13 to 571 | 11 | Some channels will not be available depending on the data rate and the selected power.<br>The module will return an error message if illegal choice. |
| S202 | Timeout to exit command mode :<br>0 : no timeout, exit through ATO or AT&RST<br>1 : Automatic programmanle output from 1 to 65565 sec. | 0 | See note 2 |
| S204 | Preamble duration<br>0 : Automatic preamble | 0 | |

| Register | Content | Default value | Comments |
|---|---|---|---|
| S210 | UART data rate:<br>0 : Autobaud<br>1 : 2.4kbps<br>2 : 4.8kbps<br>3 : 9.6 kbps<br>4 : 19.2 kbps<br>5 : 38.4 kbps<br>6 : 57.6 kbps<br>7 : 115.2kbps<br>8 : 1.2kbps | 1 | See note 1<br>The other parameters of the serial interface are :<br>• 1 stop bit -> fixed<br>• Parity -> See S212<br>• Data lenght -> Voir S211 |
| S211 | UART data lenght :<br>0 : 7 Bits<br>1 : 8 Bits | 1 | |
| S212 | UART parity :<br>0: No parity<br>1: Even Parity<br>2: Odd parity | 0 | |
| S214 | Input character in command mode :<br>ASCII code (except 0)<br>0 : Disabling entry into command mode by UART. | 43 | The input code is 3 times the character :<br>• Example : +++ if the character programmed in S214 is the ASCII code of «+» whether 43<br>• Value between 1 and 255 |
| S216 | RTS/CTS UART flow control:<br>0 : Inactive<br>1 : Active | 0 | See note 1 |
| S217 | Transmission start-up Timeout :<br>0 : no timeout<br>1 à 255 : timeout by step of 1 ms | 3 | See note 3 |
| S218 | Transmission start-up threshold :<br>From 1 to 1024 octets | 30 | The transmission starts when the number of bytes in FIFO memory to reach this threshold.<br>See note 2-3 |
| S220 | Communication mode<br>0 : Transparent<br>1 : Addressed | 0 | |
| S222 | Radio protocol<br>0 : Asynchronous paquetized non secured<br>2: Asynchronous paquetized secured<br>3: Asynchronous continuous | 3 | |
| S230 | RSSI mode:<br>0 : no RSSI<br>1 : Exit «RSSI frame» on UART<br>2 : Exit «permanent RSSI» in PWM<br>3 : Mode 1 + mode 2 active together<br>4 : Exit «permanent RSSI» on UART | 0 | |
| S231 | RF radiated power:<br>0 : 27 dbm<br>1 : 25 dbm<br>2 : 23 dbm<br>3 : 20 dbm<br>4 : 17 dbm<br>5 : 14 dbm<br>6 : 10 dbm | 0 | |

| Register | Content | Default value | Comments |
|---|---|---|---|
| S232 | Low Power modes :<br>0 : no Low power<br>1 : standby | 0 | |
| S240 | Debouncing filter on CMD & STANDBY pins<br>Adjustable from 0 to 100 by step of 1ms | 3 | |
| S241 | Command mode entry Timeout at 9.6kbps at product start-up.<br>0 : disabled<br>1 : enabled | 1 | |
| S243 | Re-emitting time out (when S222=2)<br>Adjustable from 0 to 65535 by step of 1ms | 0 | |
| S252 | Source address (or local)<br>from : 1 to 65535 | Factory pre-ini-tialized | Used in the addressed mode. This register contains the address of the module |
| S253 | Network number<br>no network : 0<br>Network address: from 1 to 254<br>255=broadcast | 0 | |
| S254 | 1: 2,4Kbps<br>3: 9,6Kbps<br>6 : 38,4kbps<br>8: 57,6Kbps | 1 | |
| S256 | Destination address :<br>From 0 to 65534<br>Broadcast function : 65535 | 0 | In addressed mode, this register must be set with the address of the module to be reached. |

**Note1** : the UART data rate should be chosen as close as possible to the radio data rate.
This is to limit the use of the buffer memory zone and activation of the RTC/CTS UART data rate control signals. E.g. 1: for a radio data rate of 57.6Kbps (S254=8), the choice of UART data rate of 57.6Kbps (S210=6) would be ideal. E.g. 2: For a UART data rate of 9.6Kbps (S210=3), the radio data rate of 9.6Kbps(S254= 3) is the best possible choice.
If it is not possible to bring the UART and Radio data rates close together the 1024 octet buffer memory will compensate for the differences in speed, provided this difference is not significant and/or the size of the data for transmission is limited.
In all other cases, only the use of the UART data rate control (S216=1) enables the integrity of the data transmitted to be guaranteed.

**Note2** : the default choice of manual exiting from the mode is suitable for use during development, when the user needs to maintain control over the exit from the command mode.
Programming of a timeout is recommended for use in operation, to enable an automatic return by the module into the communication mode if a character chain in the data flow is accidentally assimilated to a request for entry into the command mode.

**Note3** : registers S217 and S218 are used to synchronise transmission start:
- either a timeout (S217)
- or a quantity of data in the buffer memory (S218)

The first of these two limits reached triggers transmission start.
When the number of octets in the buffer memory reaches the threshold of register S218 before the timeout of register S217, it is triggering on data.
On the other hand, when the timeout of register S217 expires before the data in the buffer memory reach the threshold of register S218, it is triggering on time.

### 4.4. Configuration coherency

The NB868 module contains monitoring of the configuration coherency and prevents saving and operation of invalid set of parameters.

**Radio parameter coherency**
Radio power, radio data rate and frequency parameters should correspond to valid combinations presented in the table below (cf Appendices) and in more detail in the document entitled: "ARF868 Modem channels list" available on the Adeunis RF website.

Invalid combinations result in the return of a "W" on the AT&W and ATO commands which are not executed in this case.

## 5. Firmware upgrade

Firmware upgrade is possible through the UART port (Tx, Rx and the Boot pin are required).
Current firmware version can be read using the AT/V command
More details about this functionality is available on request. Please, contact Adeunis-RF to get all the information on firmware upgrade.

## 6. Process

### 6.1. Description of module 7763xxx

7763xx module is fully SMT, single side. Assembly process is based on leadfree alloy, no clean flux residues
PCB material is FR4 material, 6 layers, class 6 , nickel-gold finish (ENIG).

### 6.2. BOM analysis

BOM was analyzed after loading and comparison with SERMA databases; from this job, we get the following data:
- Rohs status
- Obsolescence
- MSL level
- Max peak temp during reflow
- Time max at peak temp
- Number of reflow
- Lead finish of the package
- Termination description for resistor and capacitor chips; presence of nickel barrier or not

The worst case MSL level is 3. Other parts are level 1 classified.
Most parts are compliant with max peak temperature of 260°C during 10 seconds.
Most parts are compatible with 2 reflows.
All resistors and capacitors have nickel barriers in their terminations, which is necessary to avoid leaching effect.

### 6.3. Risk linked to number of reflows

There is no high risk regarding the assembly of the module on mother board, since the land pattern is larger than the "leads" (maybe the land pattern may be little bit large compared to the "leads" and then there is risk of module slip during reflow soldering)

The stencil foil thickness should be 150 to 170 microns to ensure enough solder fillet; the stencil aperture should be reduced in length and width by 150 microns roughly to avoid solder balling in case misalignment occurs.

Check of maximum temperature (during reflow) on sensitive component body has to be done.

The trickiest point is regarding the moisture sensitivity and the way to consider the module for the assembly on mother board.

Considering the components on the module, we can define the module as a level 3 component, whose floor life under 60% max RH is 168 hours.

Having in mind that module to mother board assembly delay is not under control, same for temporary storage atmosphere, the best solution is to dry the module after test and put it in reels and then pack them in MBB bags.

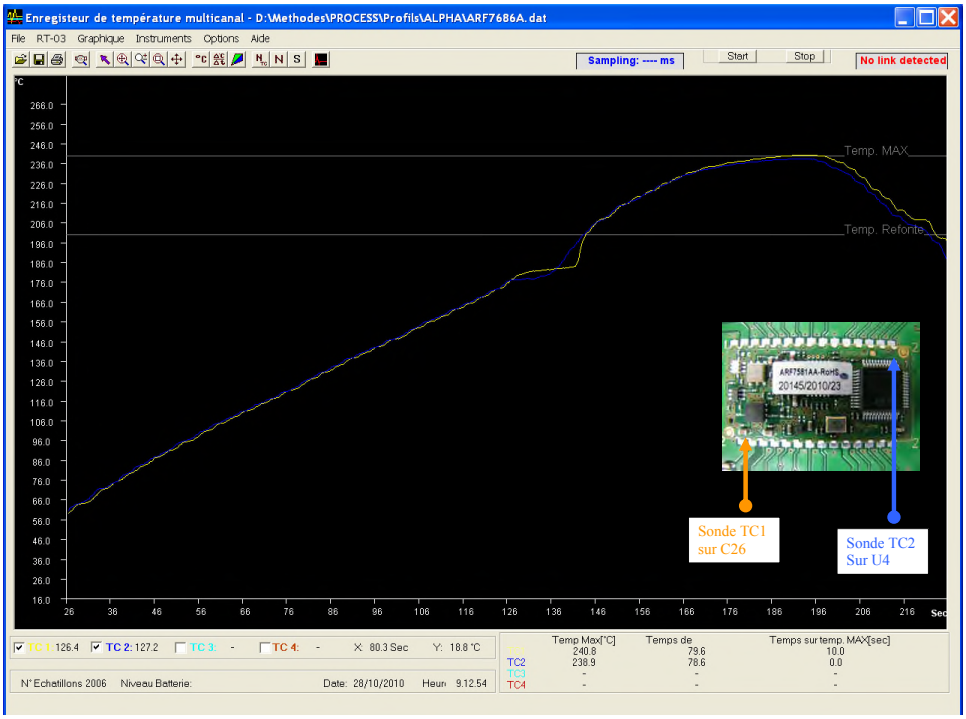
Jedec JSTD 033 standard is helping us to define the conditions of drying
If drying occurs less than 10 days after first reflow,

24 hours 90°C seems a good compromise between time and temperature;

If drying occurs more than 10 days after first reflow,

The drying condition becomes 36 hours 90°C ;
Notes:
1) at end of drying , let the parts come back to room temperature slowly to avoid condensation.
2) take care that reel material cannot withstand 90°C .Then it is needed to dry prior reeling.
Reeling should occur within a few hours after drying.

### 6.4. Soldering curve




## 7. Version history

| User guide version | Contents |
|---|---|
| V2.2.7 | Register S210 - Value by default modified |
| V2.2.6 | Register S256 value modified |
| V2.2.5 | Minimum distance between products (page 6) |
| V2.2.4 | Internal pull-up/pull down decription modified (page 4) |
| V2.2.3 | Register S254 modified |
| V2.2.2 | Command mode descripton (chapter 4)<br>Link to channel list (chapter 2.3.4.1 & 2.3.4.2) |
| V2.2.1 | Pin 16 UART_CTS description |
| V2.2 | Register S210 value updated |
| V2.1 | 3.2.1.4 Chapter modification - CRC register disabled |
| V2.0 | new firmware V2.0 description |